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Nutritional Studies in Horses

Conducted by N. Cymbaluk

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Title: Nutritional Studies in Horses

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Agency: University of Saskatchewan

Departments: Animal and Poultry Science, Herd Medicine and Theriogenology

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NUTRITIONAL STUDIES IN HORSES

Executive Summary

Attached

Technical Report

Attached

Papers and Talks

Professional Talks:

N.F. Cymbaluk and G.I. Christison. 1988. Performance of growing bulls and horses in a severe winter. In: Livestock Environment III. Proc. Third International Livestock Environment Symposium, American Society of Agricultural Engineers, St. Joseph, MI. pp 322-329.

N.F. and G.I. Christison. 1988. Applying NRC recommendations for horses under Canadian conditions. Proceedings of the Western Canadian Nutrition Conference, Winnipeg.

Extension Talks

N.F. Cymbaluk. 1987. Feeding Horses. Prince Albert Light Horse Club. Prince Albert. May.

N.F. Cymbaluk,. 1987. Feeding Horses During Winter. Vanscoy. October.

N.F. Cymbaluk. 1987. Feeding Horses. Langham 4-H Club. Langham. November.

N.F. Cymbaluk. 1988. Nutrition of Horses. Saskatoon Driving Club. Saskatoon. April.

N.F. Cymbaluk. 1988. Pasture management for horses. B.C. Horse Council. Vancouver.

N.F. Cymbaluk. 1989. Feeding the horse in winter. Moose Jaw Pony Club. March

Publications or Submissions to Refereed Journals

N.F. Cymbaluk 1989. Water balance of horses fed various diets. Equine Practice 11: 19-23.

N.F. Cymbaluk 1989. Comparison of forage digestion by cattle and horses. Canadian Journal of Animal Science. Accepted with revision.

N.F. Cymbaluk 1989. Cold housing effects on growth and nutrient demand of young horses. Journal of Animal Science. Submitted.

N.F. Cymbaluk. 1989. Effects of dietary energy source and level of feed intake on growth of weanling horses. Equine Practice. 11: 29-33.

N.F. Cymbaluk and A.D. Kennedy. 1989. Metabolic profiles and hormone responses of growing horses reared in the cold. American Journal of Veterinary Research. Submitted.

Chapters in Books or Bulletins.

N.F. Cymbaluk. Feeding Horses. Published by the Saskatchewan Agriculture - Agriculture Development Fund. ISBN 0-88656-505-7. 24 pp.

N.F. Cymbaluk and G.I. Christison. 1989. Environmental Effects on Thermoregulation and Nutrition of Horses. Vet. Clinics of North America. Equine Practice. 30 pp.

M.E. Smart and N.F. Cymbaluk. Trace Mineral Deficiencies in Large Animals. for Large Animal Clinical Nutrition eds. J. Naylor and S. Ralston.

Publications in Lay Magazines

N.F. Cymbaluk. Feeding the Horse Kept Outdoors in Winter. Horse Trails.

Expenditures

Copy attached.

Personnel and Time Involved

N.F. Cymbaluk - 100%
A. Kennedy - 5%
G.I. Christison -5%
H. Seida - 100%
C. Elian - 100% (4 mo of growth study)
L. Pryce - 100% (4 mo of growth study)

Valuable Equipment Purchased

None

EXECUTIVE SUMMARY

Sub-Title: Feeding Horses

ABSTRACT

A concise manual was written on the topic of feeding horses. The information is based on the use of Saskatchewan feeds and is applicable to Saskatchewan conditions. The data used in the manual were compiled from horse studies conducted in Saskatchewan, North America, Europe and Australia. The bulletin can serve as reference source for horse owners of variable skills and is written with the intent that horses are fed well-balanced diets at economical costs.

SUMMARY The bulletin "Feeding Horses" is included. The horse industry in Saskatchewan spends $18 million dollars on feed and supplements. These feed needs have substantial agricultural impact. The bulletin is intended to educate the Saskatchewan horse owner to the nutrient requirements of horses and dietary combinations which provide these needs. Although locally-grown feeds are appropriate horse feeds many owners still import feeds from other provinces or the United States because they do not understand nutrition or feeding of horses. Educated owners not only feed their horses well they feed them economically. That necessitates use of locally grown feedstuffs.

EXECUTIVE SUMMARY

Sub-Title: Comparative Forage Digestion by Cattle and Horses

ABSTRACT

The study aimed to determine if horses digest nutrients from Saskatchewan-grown poor and high quality hays as well as cattle and if certain nutrient or lab methods could be used to predict hay quality for cattle and horses. Horses digest poor-quality forages 25 to 35% less efficiently than cattle and need to be fed better quality hays. Crude protein was digested equally well by both types of livestock but the protein content of several grass hays was subnormal. Horses digested more calcium but less phosphorus than cattle. Mineral digestibility and content of grass and oat hays were so low that calcium and phosphorus supplementation is needed if these hays are the sole diet of any class of horse. Neither prediction equations nor in vitro methods for predicting hay intake by cattle were accurate for horses. Little of the information acquired on hay digestion by cattle is useful for predicting hay quality for horses.

SUMMARY Cattle and horses ate more of the long alfalfa hay and dehydrated alfalfa pellets than of any grass hay including Altai wildrye, bromegrass, crested wheatgrass, Kentucky bluegrass, oat hay and reed canarygrass. When fed alfalfa forages, horses used almost identical amounts of nutrient as cattle. Yet, horses digested only 25 to 35% as much energy from grass hays as cattle because they use only 25-35% as much fiber. Horses and cattle use mineral completely opposite to each other. Horses digested 75% of the calcium and 20% of the phosphorus from hays whereas cattle digested 33% of the calcium and 76% of the phosphorus. Phosphorus digestibilities by horses were well below reported values for horses fed hays grown in other regions of North America.

A side-effect of feeding the alfalfa hay and dehydrated alfalfa pellets free-choice to horses was extensive wood-chewing. This did not occur when the poorer quality hays were fed. Horses drank the same amount of water per unit of feed intake irrespective of type of hay fed. However, horses fed alfalfa urinated twice as those fed grass hays.

The implications of these observations in Saskatchewan agriculture are:

1. Forage digestion data obtained with cattle cannot be used for horses. As an example, energy digestibilities from high-quality hays (alfalfa) differed by only 2 to 5% between cattle and horses but by 10 to 15 percentage units when low-quality hays were fed. These are the first comparative data reported in Saskatchewan in which the digestibility of local feeds was evaluated in cattle and horses.

2. The nutritive value of alfalfa forages for cattle and horses is twice that of oat or grass hays. It is more economical to purchase a high-quality, albeit more costly alfalfa hay than to buy a poor-quality, cheap hay for horses because alfalfa has a higher nutrient value and is eaten in greater amounts than many grass or oat hays.

3. A drawback of the high energy and nutrient use from alfalfa forages, however, is that intakes of these hays must be controlled when fed to mature, overweight horses. Good-quality grass hay is advised for these horses. The high digestibility of the energy, crude protein and calcium makes alfalfa hays ideal roughages for growing stock whether it is horses or cattle.

4. Bromegrass was a highly palatable hay for cattle and horses which increases its nutritive value. Brome is suitable for mature horses but its nutrient density may be too low for growing horses. None of the other grass hays or the oat hay were nutritionally useful for growing horses.

5. Many of the prediction equations for hays used in nutrition labs are derived using cattle. Few of these equations apply to horses. Whereas horses digest fiber from alfalfa similarly to cattle, they digest 25-35% less fiber from grass hays. Thus, energy values for grass hays using cattle-derived equations based on fiber content must be multiplied by 0.66 to apply to horses. Extreme errors in ration formulation for horses are probable if hay nutrient content is not corrected for the different utilization efficiency of horses compared to cattle.

6. The low content and low digestibilility of calcium and phosphorus in Saskatchewan-grown, grass hays require that additional calcium and phosphorus be fed whenever these hays are the only component of the diet for livestock. A 1:1 calcium-phosphorus supplement is usually needed by horses and cattle.

7. Horses overwintered on poor-quality (or even good-quality) hays require substantial amounts of water (5 to 10 gallons daily). This amount of water cannot be acquired by eating snow.

8. Horses urinate twice as much when fed alfalfa as when fed grass hays. From a husbandry standpoint, more bedding is needed for stabled horses fed alfalfa diets than those fed grass hays.

9. <u>In vitro</u> digestibility is not a reliable nor a repeatable technique for predicting digestibility of hays by horses or cattle. This is a costly method yet had an error of 0.1 to 31% for horses and 3.5 to 64% for cattle.

10. Poor-quality, highly fibrous hays fed free-choice resulted in less wood-chewing than alfalfa hays, including long alfalfa hay. Small amounts of long, grass hays may be useful in minimizing this vice in chronically-stabled, mature horses fed alfalfa hay or pellets free-choice.

EXECUTIVE SUMMARY

Sub-title: Housing and growth in young horses

ABSTRACT

This study was performed to explain how housing affects growth, leg disorders and feed use of weanling horses fed at recommended nutrient intakes. Colts kept at 10°C gained at expected rates (0.67 kg/d) but colts kept at -5.2°C had 29% slower gains (0.52 kg/d). Clinical leg disorders (epiphysitis and contracted tendons) appeared less often and less severely in cold-housed colts. Cold-reared colts digested less phosphorus and more fibre from the diet than warm-housed colts. They also drank 15% less water at temperatures below 0°C. To get normal gain in weanlings overwintered outdoors in Saskatchewan, 1.8% more energy must be fed per Celsius degree drop below 0°C above energy intakes currently recommended for growing horses. The 1989 NRC energy values given for weanling horses must be adjusted for Saskatchewan winter temperatures.

SUMMARY The connection between growth, housing and soundness was assessed in weaned Standardbred colts reared in heated and unheated barns during a typical Saskatchewan winter. Colts were fed diets to meet 1989 minimum nutrient needs. Warm-housed colts (10°C) gained normally (0.67 kg/d) but those kept in an unheated barn (-5.2°C) gained 29% more slowly (0.52 kg/d). Bone growth, measured by wither and croup height, was 5% slower but not statistically different for cold-housed colts. Cold-reared colts had haircoats twice as heavy as warm-housed colts and had not shed their hair into early May. Warm-housed colts had shed their winter hair by April. Most nutrients were equally well-digested by both groups of horses except cold-housed colts digested less phosphorus and more fiber. They also drank 15% less water.

The body condition of all colts improved 1 to 2 scores during the study. Clinical leg abnormalities (contracted tendons and epiphysitis) occurred more frequently and with greater severity in warm-housed colts. Cold-housed colts were clinically normal after week 8 except for one colt who had an upright conformation. Four of six warm-housed colts had moderate pastern uprightness and three of these were knuckling at the fetlock in early May.

The implications of these findings for Saskatchewan are:

1. Overwintering weanling horses in unheated shelters (-5°C) caused a 29% decrease in daily gains although these colts were fed to meet 1989 NRC energy intakes. The feed:gain ratio for cold-housed colts was 11.25 compared to 8.77 for warm-housed colts. The extra feed cost of keeping a young horse outdoors in a typical Saskatchewan winter was estimated at $58 dollars per horse. The heating cost of an insulated, well-ventilated barn would be $1.25 over winter.

2. Rates of skeletal growth were not statistically different between groups although skeletal growth was 2.5 to 7.5% lower for cold-housed horses. By the time a horse is mature (2-3 yrs of age), these differences are generally negligible because growth rates increase during summer. However, when selling young stock, smaller sizes may be a disadvantage.

3. More frequent signs of pastern uprightness, indicating contracted tendons or flexure deformity, and epiphysitis occurred in warm compared to cold-housed colts. These disorders may have arisen from changes in hormone levels or

increased net energy available for growth. Further studies are needed to identify causes of these leg abnormalities which allow feed and management strategies to minimize leg disorders in growing horses.

4. Young horses reared outdoors in a typical Saskatchewan winter need 1.8% more energy per degree Celsius decrease below 0°C than recommended by 1989 NRC guidelines for moderate growth. This shows that 1989 NRC energy intakes are inaccurate for horses reared outdoors during a Saskatchewan winter. At -30°C, a growing horse will need 50% more of a 63% TDN feed than at 0°C. This intake is 3.3% body weight which is exceeds maximal gut capacity of a horse. Young horses must be fed highly digestible diets during growth and especially during winter.

5. Digestion of a mixed hay-grain diet by horses was unrelated to housing temperature but decreased with age. The extra feed needed to compensate for lower energy use with maturity is about 2% per month of age after 6 months.

6. Crude protein digestion does not change with cold weather. Thus, crude protein content in diets of weanling horses does not have to be increased above the recommended concentration of 13% (as fed).

7. Cold and age reduced phosphorus digestibility in young horses. Low phosphorus utilization can reduce heat production needed for cold tolerance and can reduce bone quality and soundness. In Saskatchewan, it is advisable to increase dietary phosphorus content for weanlings housed outdoors in winter from the recommended concentration of 0.30% to 0.35 or 0.4%.

8. Calcium digestion was unaffected by cold. Therefore, calcium content of the diet does not need to be increased above 0.50%. However, a 20% increase above NRC values is advised to allow for individual variation in calcium use.

9. Water intake was reduced in cold weather. A more digestible feed is recommended for young horses overwintered outdoors to reduce the water needed to move undigested material through the gut. This reaffirms the advice that snow is not a suitable water substitute for horses in winter.

EXECUTIVE SUMMARY

Sub-title: Housing, metabolic profiles and hormone production by young horses

ABSTRACT

The connection between housing and growth was evaluated in weanling Standardbred colts kept in warm and unheated barns with the aim of describing blood components which might indicate cold intolerance or leg unsoundness. Cold-housed colts reacted exactly opposite to cattle in their response to cold temperature. A decrease in blood glucose content, a change in proportion of blood calcium to phosphorus and sluggish thyroid function appeared to depend on season (day length) and to a lesser extent on temperature. These data have never been described before for growing horses over winter. Although more study is needed to confirm these theories, low levels of blood thyroid hormone and phosphorus may be reduce cold tolerance and affect bone growth and quality in young horses. Different feed management may be needed in Saskatchewan winter conditions to prevent abnormal growth in weanling horses.

SUMMARY The metabolic profiles of cold-housed colts indicated that cold temperatures reduced blood glucose and phosphorus but increased blood calcium content and alkaline phosphatase activities. Except at week 5, thyroid hormone levels were lower in cold-housed colts than warm-housed colts throughout the study. TRH stimulation tests indicated that thyroid function was slower for both groups in February compared to April but that cold-housed colts were generally less responsive in thyroid hormone secretion than warm-housed horses. Thyroid hormone secretion appeared to be dependent on season with modification by ambient temperature and energy status.

The implications of these findings are:

1. Cold stress of weanling horses (-5.2°C) produced metabolic profiles indicating subnormal energy balance despite being fed at "normal" energy intake. This substantiates our previous conclusions that 1989 NRC energy recommendations for weaned horses are inadequate for Saskatchewan winter conditions.

2. Cold-housed weanlings had higher blood calcium and lower blood phosphorus concentrations indicating that bone quality may differ in young horses kept in the cold. It does not confirm that bone quality is worse. This data further supports increasing dietary phosphorus concentration from 0.30% to 0.35% or 0.40% for cold-housed, weanling horses.

3. Cold-housed weanlings secreted less thyroid hormone in response to cold temperatures. Thus these horses which were fed "normal" energy intakes by current 1989 NRC recommendations responded to cold stress like wild ruminants (deer) rather than cattle. Low thyroid hormone production may indicate

subnormal energy intake, cold intolerance or a different metabolic strategy by horses for adapting to cold. Increasing dietary energy or changing the diet to a higher portion of forage may benefit horses thermodynamically by increasing heat increment and thus, their cold tolerance. This hypothesis remains to be confirmed.

4. Thyroid function of weanlings kept in a cold barn was sluggish throughout winter. This effect was confirmed by TRH stimulation. Low production of thyroid hormones has two implications: 1) a decreased cold tolerance in young horses kept outdoors in winter and 2) a possible negative effect on bone development. These hypotheses need to be confirmed but may be the explanation for the seasonal occurrence of growth disorders in young horses grown in Saskatchewan.

5. Young horses reared outdoors in winters have several potential reasons for subnormal bone growth: insufficient energy intake, reduced mineral absorption and reduced thyroid hormone production. In contrast to expectation, cold-housed horses had a lower incidence of leg abnormalities during winter. Whether this leg soundness was permanent or temporary cannot be stated. However, seasonal changes in thyroid hormone levels may partially explain why leg abnormalities such as epiphysitis and contracted tendons occur at specific ages. These hypothesis must be further examined since they may be an exciting solution to a chronic problem of young horses.

EXECUTIVE SUMMARY

Sub-title: Water balance of horses fed various diets

ABSTRACT

The effect diet has on water intake by horses was examined by reviewing the data from several digestion trials in which 39 separate feeds were used. The aim of the study was to provide guidelines for water needed by horses under various feeding programmes and to describe how diet alters water balance in horses. Water intake was shown to depend on feed intake. Diets of long grass or long alfalfa hay caused horses to drink more water than diets which were pelleted. Alfalfa hay diets, however, caused more water to be excreted in urine. Low-quality, grass hay diets increased the water retained in the gut and excreted in manure. This implies that adequate water must be given to horses fed poor-quality hays to prevent impaction. More bedding is needed for horses are fed alfalfa hay diets because of their higher urine output.

Summary Horses need 2 to 3.2 liters of water/kg feed. Water intake depended on dry matter (feed) and fiber intake. When fed long or chopped, hay type did not affect water intake but pelleting the ration reduced water intake. As digestible energy content of the diet increases, horses drink less water and have drier feces. Diet determined the route by which ingested water was excreted. When grass hays were fed, 55% of the consumed water was excreted in manure indicating substantial water was retained in the gut. Yet, urine was the main route of excretion (44 to 56%) when legume hays or complete pelleted diets were fed. Horses fed these diets absorb much of the water and then excrete it in urine. Urine output depended on amount of water consumed, amount of water excreted in feces, and crude protein intake. The amount of water lost in sweat and in breathing was about 14 to 24% of total water consumption.

The implications of these findings are:

1. The voluntary water intake by idle horses fed at maintenance and housed at 15 to 20°C ranged from 2.0 to 3.3 liters/kg DM feed. Mature horses need at least 13.5 to 22.8 liters water (3 to 5 gallons) daily but the amount needed depends on feed intake and type of diet.

2. Horses fed long hays (grass or alfalfa) drink more water than horses fed processed feeds (grain, alfalfa pellets). Generally, horses overwintered in Saskatchewan are fed long hay and need more, not less, free water to maintain normal bowel movement. Snow is not a good substitute for water.

3. Horses fed alfalfa hay produce more urine which increases the bedding required for stabled horses fed high legume diets, e.g. alfalfa.

4. Concentrated urine is important in production of pregnant mare's urine (PMU). Our data confirm that grass hay-grain diets are the most suitable for PMU conditions. These diets reduce urine production (i.e. increase urine concentration) while decreasing the desire for free water.

5. From a veterinary standpoint, diet must be controlled when treating horses with kidney or gut disorders and when selecting a drug regimen. Some drugs are excreted via the gut; others through urine. Diets such as alfalfa hay could decrease effectiveness of drugs that are excreted by the urinary route by increasing the excretory rate. That is, the more urine that is produced, the greater the drug clearance rate.